CSS Long Term Control Plan
Update Alternatives

Alternatives Evaluation: Storage Tanks

City of Alexandria, VA
Department of Transportation and Environmental Services

FINAL – October 2015

GREELEY AND HANSEN

Table of Contents

Table of Contents

List of Tables

List of Figures

Attachments

Executive Summary

Storage tanks are a common and accepted technology for storage of combined sewage overflows. During a rain event, the combined sewer overflow is diverted to storage tanks. After the rain event, the stored volume is sent to Alexandria Renew Enterprises (AlexRenew) Water Resources Recovery Facility (WRRF) for a high level of treatment. The storage tanks can either be constructed above ground or below ground. The storage tank(s) are located in the vicinity of the existing outfalls. Although not specific to combined sewers, underground storage tanks have been installed in the City at the Four Mile Run Pump Station located at the north end of Commonwealth Avenue. Arlington County utilized above ground storage tanks at their wastewater treatment plant (intersection of Route 1 and S. Glebe Road).

In-stream storage, earthen basins, and open concrete tanks were considered and eliminated from further consideration due to the highly urbanized environment of the City. Above ground storage tanks are feasible; however, have aesthetic impacts and large pumping needs as disadvantages. Below ground storage tanks, and associated ancillary facilities, are the basis of the evaluation in this technical memorandum.

In general, below ground storage tanks remain a feasible alternative when sizing criteria is based on capturing and retaining the CSO volume of the 5th largest storm in the typical year of 1984 (ST002-A), particularly for CSO 002. Space limitations make storage tanks at CSO 003 and 004 (ST003/4-A) less favorable and likely impractical. Table ES-1 summarizes the alternatives used for the full evaluation.

Table ES-1
Storage Tank Cost Estimate Summary

Alternative (cost in millions)	Storage Volume (MG)	Construction Cost	Project Costs	Land Costs	Wet Weather Improvements	Total
ST002-A	2.0	$19.5	$6.8	$3.5	$0.0	$29.8
ST002-B	25.9	$138.4	$48.4	$21.6	$0.0	$208.4
ST003/4-A	0.8	$10.3	$3.6	$2.9	$37.7	$54.5
ST003/4-B	18.0	$105.0	$36.8	$25.5	$37.7	$205.0

The estimated planning costs associated with storage tanks are higher than costs in other areas due to the high land costs and the difficulty of implementing such a project in the City of Alexandria.

It is recommended Alternative ST002-A and ST003/4-A be moved forward for scoring and ranking relative to the other alternatives.

Alternatives ST002-B and ST003/4-B are unfavorable and impractical due to the very large volume requirements, insufficient land availability, and extraordinarily high capital costs. It is recommended ST002-B and ST003/4-B be eliminated from further consideration.

Section 1 Storage Tanks

1.1 Overview

Wet weather flows exceeding the system conveyance/treatment capacity can be stored for subsequent treatment at the AlexRenew WRRF. Storage control methods include in-line storage (pipes), off-line storage (storage tanks), and deep tunnel storage. Storage facilities may be located at overflow points or near dry weather or wet weather treatment facilities.

Limitations of storage facilities are primarily finding an adequate site acceptable to the community and the issues with operating and maintaining a wastewater storage facility remote from the main treatment plant. A major factor determining the feasibility of using this technology is the land availability. Operational and maintenance cost are generally moderate. Different types of CSO storage facilities are described below.

1.2 Storage Location

Storage is most cost effective if it is located close to the existing CSO outfall(s). This type of facility is referred to as satellite storage because it is located away from the wastewater treatment plant (WWTP). Satellite storage minimizes the cost of conveyance to the WWTP. AlexRenew is constructing nutrient management facilities for the purposes of optimizing nitrogen removal. These facilities provide an ancillary benefit of storing some wet weather flow under certain conditions. Additional storage at AlexRenew requires significant improvements to the conveyance (sewer) system. Conveyance improvements of this type are likely accomplished by tunneling. Tunnels provide a dual function of storage and conveyance often minimizing or eliminating the need for satellite storage or additional WWTP storage. Tunnel storage and conveyance is considered in a separate technical memorandum. This memorandum addresses only satellite storage located near the existing outfalls.

1.3 Storage type

1.3.1 In-Stream Storage

Systems are available to store CSOs in the receiving water at the discharge of a CSO outfall. These systems use floating curtains around the outfall to create a storage chamber for CSO in the water body. Baffles are provided to avoid short circuit and curtain openings are available for overflow relief. After the CSO event the flows are pumped back to the system and conveyed to the wastewater treatment plan. This chamber is not covered and has no bottom constructed. This will negatively impact the area due to aesthetic, odor and sanitation concerns. Because of these factors, in-stream storage of CSO will not be considered further.

1.3.2 Earthen Basins

These facilities are utilized where relatively inexpensive land is available that is remote from the public. Typically the earthen basins utilize sloped sides, are uncovered and include a synthetic liner or concrete liner to prevent exfiltration and facilitate maintenance. Earthen basins are typically used in relatively unpopulated areas. Considering the lack of available land and the highly urbanized environment of the City, earthen basins are eliminated from further consideration.

1.3.3 Open Concrete Tanks

Open concrete tanks used for storage of CSO are similar than earthen storage but with vertical walls, and constructed with reinforced concrete. It is impractical to collect odors emanating from open tanks and as a result include the potential to impact local land uses. Given the urban nature of feasible storage locations in the City, open concrete tanks are eliminated from further consideration.

1.3.4 Closed Concrete Tanks

Similar to open concrete tanks but covered to minimize aesthetic and environmental impact. Closed concrete tanks may include odor control facility, washdown/solids removal system, and access for cleaning and maintenance. When constructed below grade, the surface at grade provides to the potential be used for parks, playgrounds, parking, or other uses at additional costs. Closed concrete tanks are potentially viable alternatives and therefore been retained for further consideration.

1.3.5 Above Grade vs. Below Grade Tanks

Above grade storage requires that combined flow be pumped to storage and later drained by gravity. With below grade storage, combined flow fills the tank by gravity and is either drained by gravity or pumped out after the storm. Large capacity pumps are required for above grade storage to handle peak flows during a storm. Typically a storage tank is drained slowly over a day or more after a storm, as a result the drain flow does not exhibit high peak flow so much smaller pumps can be used for the below grade tanks.

The Arlington County Pollution Control Plant has above grade wet weather storage tanks on site at their WWTP adjacent to Glebe Road. AlexRenew has below grade storage tanks the Four Mile Run Pumping station adjacent to Cora Kelly School. Above grade tanks have a much greater visual impact than below grade tanks.

Above grade tanks are typically less expensive than below grade tanks; however, the larger capacity pump station will offset a portion of those savings.

Due the highly urbanized areas at CSOs-002, 003, and 004, below grade tanks will be the basis of the storage tank alternative. However, if tank storage is selected, above grade storage could be considered further.

1.3.6 Construction Method

<u>Pre-Cast Post Tensioned Tanks</u>

Pre-cast post tensioned tanks (PPT's) are designed for different uses including as follows: water storage, wastewater treatment, storm overflow, effluent storage and others. PPT's can be constructed in different configurations, as rectangular, circular or elliptical structures and also above grade, below grade, or partially buried. The elements are manufactured at certified facilities and the construction requires less time compared with cast in place concrete. The footprints can be smaller if are designed with deeper walls. Interior surface maintenance costs are reduced and exterior coatings are not required. A local example of a PPT is the Nutrient Management Facility at AlexRenew.

Pre-stressed Concrete Tanks

Pre-stressed concrete is common for water and wastewater storage. These tanks can be constructed partially or completely buried and interior surface maintenance costs are reduced and exterior coatings are not required. Pre-stressed concrete tanks provide watertightness, structural integrity, and could be designed with an architectural appeal. Most pre-stressed tanks for wastewater treatment are built in a circular configuration. A local example of pre-stressed concrete tanks is the flow equalization tanks at the Arlington County Pollution Control Plant.

1.4 Components

1.4.1 Screening

CSO storage tanks can include some form of screening to prevent large debris from entering the tank where it can be difficult to remove. Screens also protect pumping equipment from clogging. Some storage facilities use bar screens to control floatables and bigger size debris from entering the storage tank. The AlexRenew storage facility near Cora Kelly School uses a netting system. For this preliminary alternatives evaluation 6” static bar screens on the influent to the tank are assumed for cost estimating purposes. Additionally, 2” static bar screens are assumed on the tank discharge to protect the dewatering pumps.

1.4.2 Pump Station

Storage tanks will require a pump station to fill the tank if it is above grade; or to pump back the stored wastewater to the interceptor when the head is not enough to discharge by gravity. A pump station that fills the tank must be sized sufficiently large to handle peak flows. Pump stations that pump back the stored flow can be sized much smaller and pump the flow back over a longer period of time. For this alternative evaluation, where below grade storage will be used in the evaluation, pump back storage will be used. The pumps are a submersible chopper pumps.

1.4.3 Tanks and cleaning

Storage tanks are designed to capture a selected volume of CSO and then attenuate the peak combined sewer flows. After the storm the stored flow is discharged in a controlled manner back to the interceptor system for treatment. Tanks must be designed to prevent the CSO from becoming septic. It should include components to control and remove the accumulation of solids and floatables. This is accomplished by designing the tanks with bottom slopes that drain well and flushing systems to remove remaining debris after the tank is drained.

1.4.4 Odor control

Public perception is an important factor on the design of CSO storage facilities. Therefore aesthetic elements are usually included to limit the impact to the surroundings, including odor control systems. Typical odor control systems include covers to contain them and prevent dispersion, carbon adsorption and wet scrubbers, exhaust air trains, activated carbon vessels, and fans.

1.5 Sizing

Two scenarios were studied to size the storage tank facility to reduce CSO volume and frequency to meet the goal of the TMDL:

- Scenario A: Capture and retain the CSO volume of the 5th largest storm in the typical year (1984), for CSO outfalls 002, 003 and 004. Consistent with the presumption approach (i) of the National CSO Policy, which results in four overflows per year in the typical year.
- Scenario B: Capture and retain the CSO volume to achieve 80% (002) and 99% (003 and 004) bacteria reduction for the largest storm in the 2004-2005 TMDL period.

The Scenario B sizing is in strict accordance with the assumptions and requirements of the TMDL modeling. The TMDL modeling was based on 80% control for CSO 002 and 99% control for CS0 003 and 004 during each day. Alternatively, Scenario B could be achieved on an annual basis with reduced sizing. For example CSO 002, could be sized to capture 100% of most of the storms, but less than 80% of the really large storm event. As noted in the *Regulatory Requirements Technical Memorandum*, the City has repeatedly raised concerns with many of the assumptions associated with the TMDL modeling. The City believes the assumptions do not represent the actual nature of CSO impacts or an understanding of how CSOs are typically controlled.

1.5.1 Volume and Flowrate

The design volume and flowrates used to size the storage tank facility and pump stations for each scenario are presented on Table 1-1.

Table 1-1
Storage Volume Required for CSO Outfalls for Scenarios A and B

Storage Alternative	Scenario	Unit	CSO-002	CSO-003/4
1984 5th largest storm overflow volume	A	MG	2.0	0.8
1984 5th largest storm CSO flowrate	A	MGD	16.6	11.0
2005 Peak storm overflow volume	B	MG	25.3	17.6
2005 Peak storm CSO flowrate	B	MGD	113.4	95

1.5.2 Storage Tanks Sizing Requirements

The tank could be installed below grade and filled and discharged by gravity. There is limited head available between the diversion point on the system towards the storage tank and the effluent discharge manhole. This head allows a maximum side water depth of 5.5 feet. This will result in tanks with a large footprint to store the required volume. Due to the large footprint and limited head, gravity fill and discharge tanks are not considered further.

Table 1-2 shows the preliminary designs of the CSO storage tanks including a pump station for dewatering for Scenario A.

Table 1-2
Storage Tank with Dewatering Pump Station for Scenario A

Storage Facility	Unit	CSO-002-A	CSO-003/4-A
Side Water depth	ft	20.0	20.0
Length	ft	132	72
Width	ft	100	72
Footprint Area	sf	13,200	5,184
Storage Volume	MG	2.0	0.8
Dewatering Time	hours	24	24
Pump Station Capacity	MGD	2.0	0.8

A deeper tank with a dewatering pump station considerably reduces the footprint of the facilities compared with the ones with discharge by gravity.

The locations of these facilities are shown in the following section. A 2.0 million gallons tank is required for the CSO 002 outfall, the size of the tank is manageable and there are locations available close to the outfall for the installation of the tank.

For the outfalls of CSO 003 and 004, 0.8 million gallons is evaluated. There is limited space available at the area of the outfalls. A cul-de-sac close to the CSO 003 outfall could be used for the installation of the tank.

Table 1-3 shows the preliminary designs of the CSO storage facilities including a pump station for dewatering the Scenario B tank.

Table 1-3
Storage Tank with Dewatering Pump Station for Scenario B

Storage Facility	Unit	CSO-002-A	CSO-003/4-A
Side Water Depth	ft	20.0	20.0
Length	ft	800	500
Width	ft	220	240
Footprint Area	sf	176,000	120,000
Storage Volume	MG	26.3	18.0
Dewatering Time	hours	24	24
Pump Station Capacity	MGD	26.3	18.0

The tanks for the B Scenarios are considerably larger than the projected sizes for Scenario A. For CSO 002 a 26.3 MG tank is required. For the storage tank of the outfalls of CSO 003 & 004 an 18.0 MG tank is required.

1.6 Location and Layout

Locations for storage facilities for CSO 003 and CSO 004 are very limited and require the taking of existing land as shown the following figures. Locations for CSO 002 are less restrictive than for CSOs 003 and 004. For this stage of the evaluation, a site south of the Wilson Bridge is used. Additional potential sites could include at the Royal Street cul-de-sac north of the bridge, in the parking lot under the bridge, or in the Jones Point Park (National Park Service). Note that tunneling options also provide storage. The *Tunneling Technical Memorandum* will consider options on the north side of the Wilson Bridge.

Figure 1-1
CSO-002 Storage Tank, Scenario A (ST002-A)

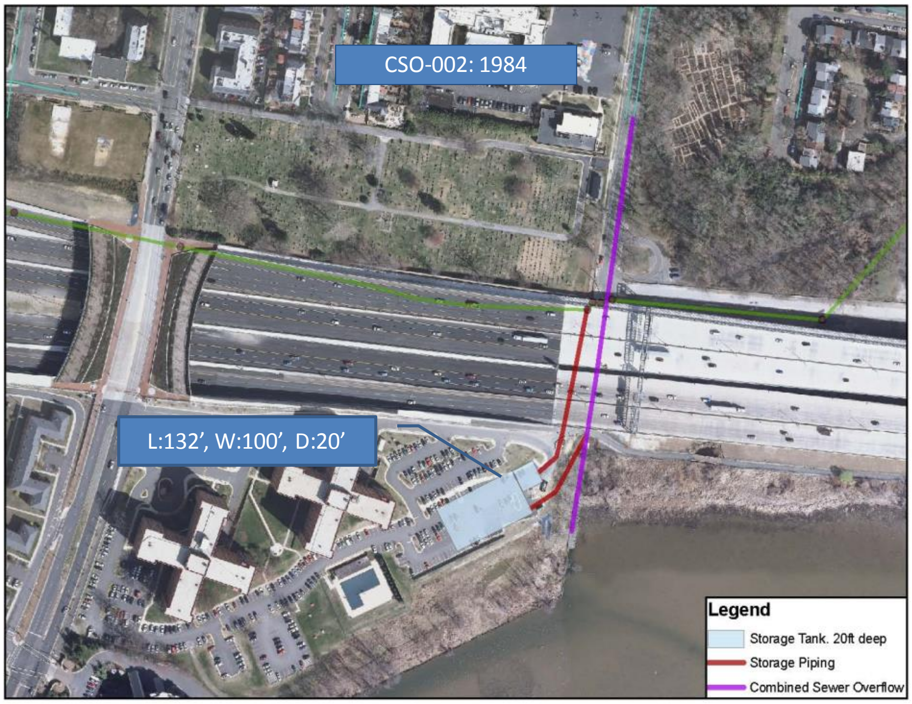


Figure 1-2
Profile CSO-002 Storage Tank, Scenario A (ST002-A)

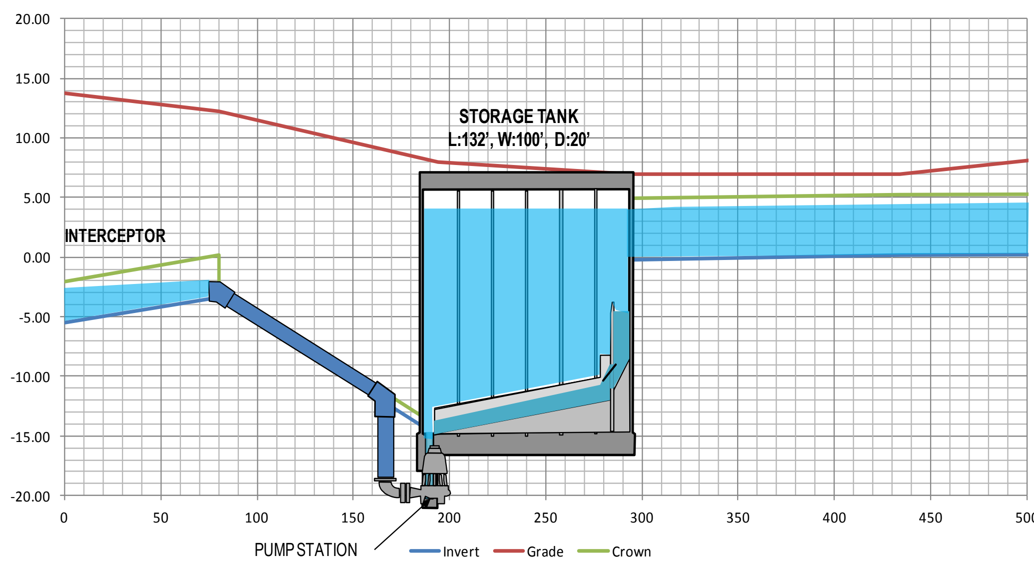


Figure 1-3
CSO-002 Storage Tank, Scenario B (ST002-B)

Figure 1-4
Profile CSO-002 Storage Tank, Scenario B (ST002-B)

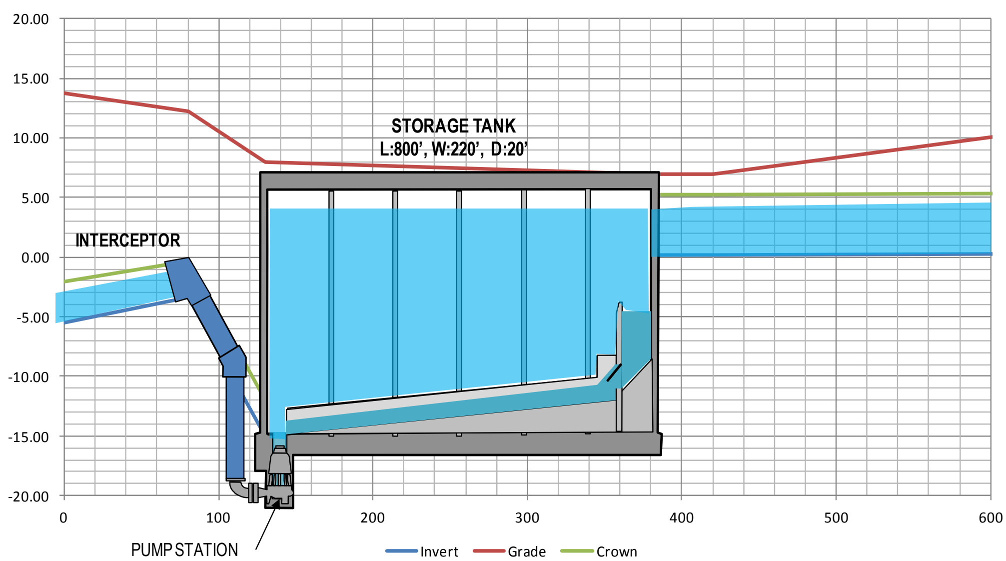


Figure 1-5
CSO 003/004 Storage Tank, Scenario A (ST003/4-A)

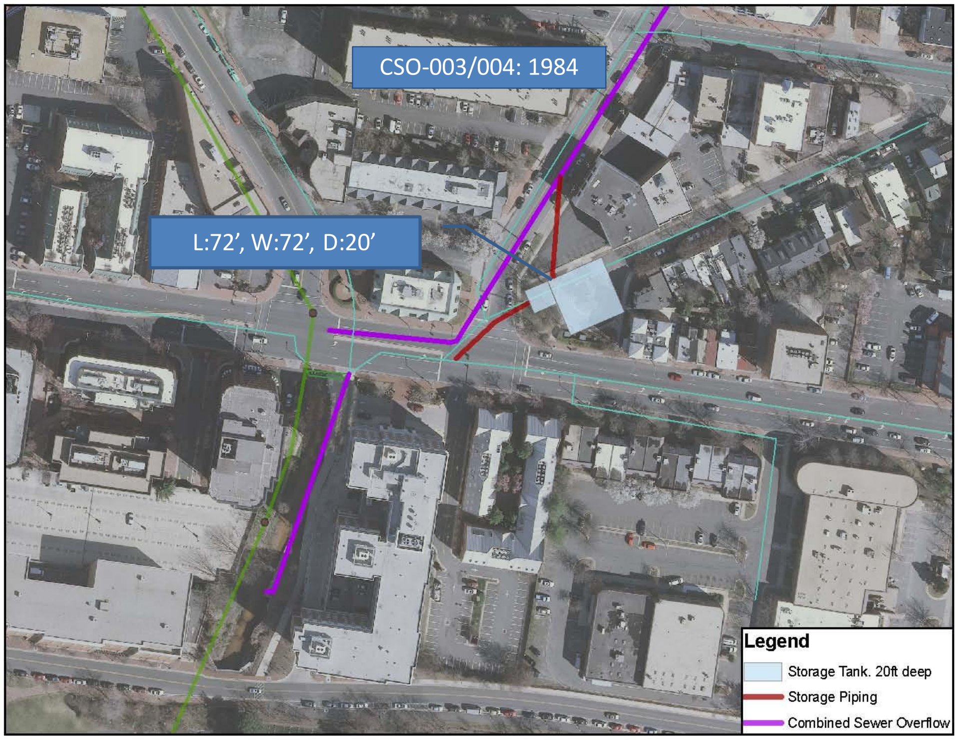


Figure 1-6
Profile CSO 003/004 Storage Tank, Scenario A (ST003/4-A)

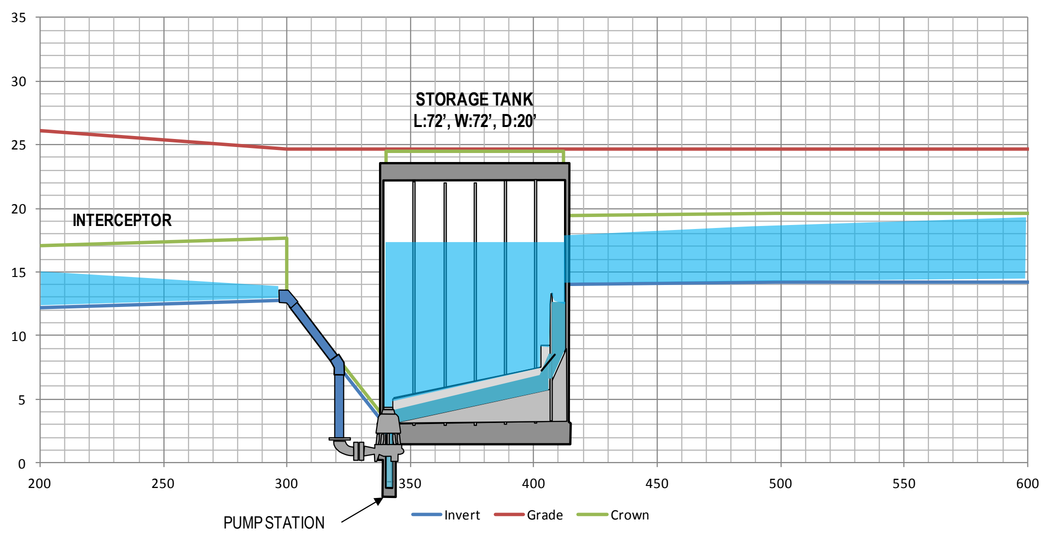


Figure 1-7
CSO 003/004 Storage Tank, Scenario B (ST003/4-B)

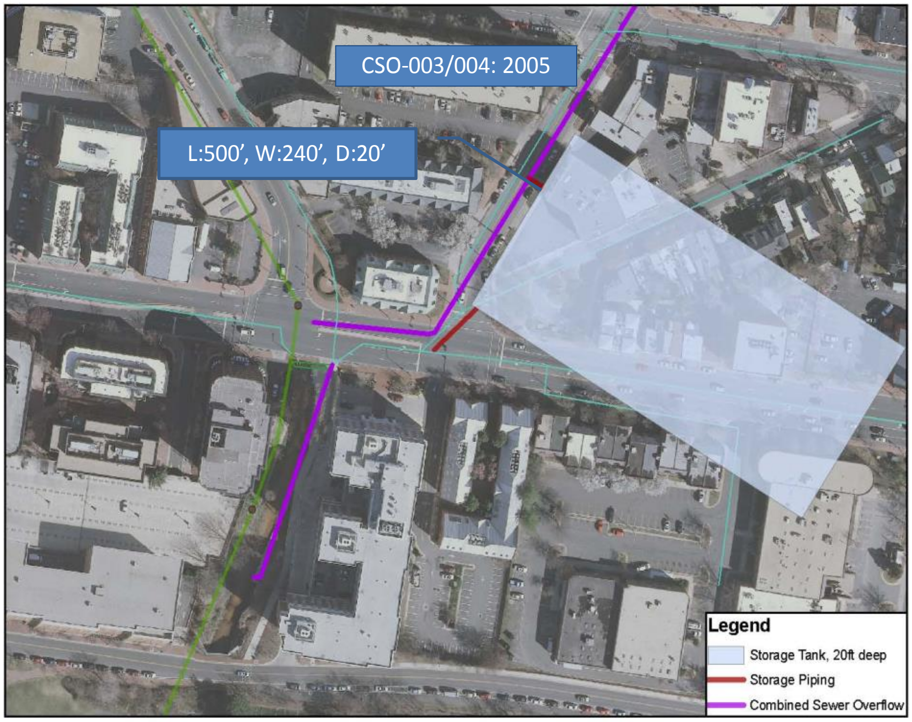
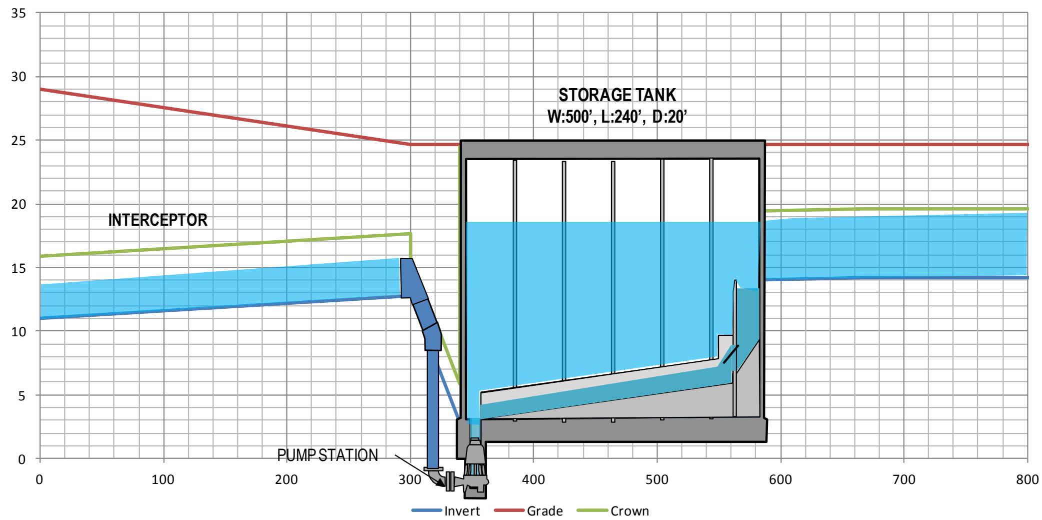


Figure 1-8
Profile CSO 003/004 Storage Tank, Scenario B (ST003/4-B)



Section 2 Evaluation Criteria

The storage tanks alternatives are evaluated based criterion defined in the *Evaluation Criteria Technical Memorandum* and include:

- Cost
- CSO Reduction (CSO Volume)
- Effectiveness
- Implementation Effort
- Impact to the Community
- Expandability
- Net Environmental Benefit
- Nutrient Credits for the Chesapeake Bay TMDL
- Permitting Issues
- Required Maintenance

The *Alternatives: Ranking and Recommendation Technical Memorandum* will rank the alternatives based on the above criteria and established weighting. The follow sections are provided to illustrate how the individual CSO alternatives will rank.

2.1 Cost

A cost curve for storage tanks (million dollars vs. storage volume in MG) was developed in the *Basis for Cost Opinions Technical Memorandum*. The curve just considers the construction cost of the storage tank. Additional costs were estimated for pump stations, screens, odor control facility and land acquisition. The complete cost estimate is provided in Attachment A.

2.1.1 Capital

The estimated costs for the storage tank alternatives are estimate based on the guidance provide in the *Basis of Cost Technical Memorandum* and are shown below. The cost estimate is included as Attachment A.

There is project, independent of the LTCPU, currently under consideration by the City, AlexRenew, and Fairfax County to provide wet weather improvements that eliminate sanitary sewer overflows (SSOs), address basement backups during large wet weather events, as well other benefits for the King and West sewershed (CSOs 003 and 004). Unlike other alternatives (i.e. tunnels), these wet weather improvements cannot be addressed through storage tanks alone. In order to normalize the cost of the alternatives, the estimated capital costs of these wet weather improvements are included for alternatives ST003/4 A and B.

Alternative (cost in millions)	Storage Volume (MG)	Construction Cost	Project Costs	Land Costs	Wet Weather Improvements	Total Capital Cost
ST002-A	2.0	$19.5	$6.8	$3.5	$0.0	$29.8
ST002-B	25.9	$138.4	$48.4	$21.6	$0.0	$208.4
ST003/4-A	0.8	$10.3	$3.6	$2.9	$37.7[1]	$54.5
ST003/4-B	18.0	$105.0	$36.8	$25.5	$37.7[1]	$205.0
[1]Select wet weather improvements, including hydraulic grade line control structure, AlexRenew WRRF upgrades and the wet weather pump station will be shared facilities with Fairfax County. The cost split for these shared facilities will be determined at a later date						

The estimated planning costs associated with storage tanks are higher than costs in other areas due to the high land costs and the difficulty of implementing such a project in the City of Alexandria.

2.2 CSO Reduction (CSO Volume)

Utilizing XPSWMM hydraulic modeling software, the CSO volume reduction has been estimated and ratings have been assigned to each alternative. Percent reduction after the construction of the CSO controls relative to the prior condition. The percent capture is an estimate of the total CSO captured and treated. For Scenario A, the typical year (1984) provides the baseline for the estimated reduction and capture. For Scenario B, the TMDL period (2004-2005) provides the baseline for the estimated reduction and capture.

Alternative	CSO Volume Stored and Treated (MG/YR)	Comparison Year(s)	Percent Reduction	Percent Capture	Rating
ST002-A	36.8	1984	85.8%	94.2%	High
ST002-B	59.6	2004-2005	95.5%	97.1%	Very High
ST003/4-A	14.6	1984	81.7%	96.1%	High
ST003/4-B	33.9	2004-2005	100%	100%	Very High

2.3 Effectiveness

The effectiveness is based on how well each alternative reduces the bacterial input to the receiving waters. The effectiveness of each alternative is based on the CSO volume reduction and discharge location.

Alternative	Comparison Year	Bacteria Percent Reduction	Rating
ST002-A	1984	85.8%	High
ST002-B	2004-2005	95.5%	High
ST003/4-A	1984	81.7%	High
ST003/4-B	2004-2005	100%	Very High

2.4 Implementation Effort

The implementation criterion is the feasibility and effectiveness with which all the projects in a CSO control alternative can be successfully completed. Implementation factors are presented in the form of questions in the table below.

The size of the storage facilities for Scenario B that use the peak storm of 2005 are extraordinarily large and there are no available sites for construction.

Under the A Scenario, the storage tank footprints were more feasible, particularly for 002. For CSO outfall 002 an existing parking lot west of the outfall was considered as a potential site for the storage system.

For CSO 003 and 004 there is just one potential site for the storage tanks at the northwest quadrant of the Commerce Street and Duke Street intersection. Figure 1-5 identifies the potential site, however, the site constraints (adjacent to the very busy Duke Street, highly urbanized area, and unknown utilities) will make for difficult construction, operation, and maintenance of the storage tank, pump station, and associated facilities.

Implementation Questions	ST002-A	ST002-B	ST003/4-A	ST003/4-B
Are construction projects low in complexity and utilize commonly implemented technology?	Yes	Yes	Yes	Yes
Is land available in the proposed project areas?[1]	Yes	No	No	No
Are there adequate amount of resources, labor, and expertise to complete projects?	Yes	No	Yes	No
Can the proposed project(s) be reasonably constructed in the highly urban environment of Old Town Alexandria?[2]	Yes	No	No	No
Is it likely the LTCP deadlines will be met?[3]	Yes	No	No	No
Rating	Very High	Minimal	Low	Minimal

[1] The size of the Scenario B storage tanks make it infeasible to locate near the existing outfalls in a highly urbanized environment. The 003/4 storage facilities are located near outfalls 003 and 004 in a very urbanized environment with an unknown number of conflicting utilities and a complex sewer system in the vicinity, for both the A and B scenarios.

[2] The Scenario B storage facilities are too large to construct in Old Town Alexandria. There is not a suitable location for the ST003/4 storage facilities for either Scenario A or B.

[3] Due to the complexity of constructing storage facilities in the highly urbanized environment it will not be reasonable to meet the 2035 deadline.

2.5 Impact to the Community

The impact to the community is very important for CSO facilities, especially because CSOs 002, 003 and 004 are located in a highly urbanized area. The design of CSO storage tanks should incorporate aesthetic elements that help the facilities to blend with the surroundings creating parks, recreational areas, using covered tanks, and likely include odor control. The storage facilities evaluated are underground to avoid the visual impact once constructed.

There appears to be space in the area of CSO 002 to construction a storage tanks and associated facilities for ST002-A, although it will require securing private property. Alternative ST003/4-A is feasible, but impractical due the highly urbanized area around CSOs 003 and 004.

Impact on Business and Public Rating	Description	ST002- A	ST002- B	ST003/4-A	ST003/4-B
High	Improved quality of life and minimal negative impact during implementation				
Medium	Some negative impact during implementation	X			
Low	Excessive negative impact during implementation		X	X	X

2.6 Expandability

Due space limitation there are only limited options to expand ST002-A and virtually no opportunities to expand the remaining alternatives.

Expandability Rating	Description	ST002-A	ST002-B	ST003/4-A	ST003/4-B
High	Multiple options and space for expansion				
Medium	Few options and space for expansion				
Low	Limited options and space for expansion	X			
Minimal (or none)	No opportunities for expansion		X	X	X

2.7 Net Environmental Benefit

The net environmental benefit is based on each alternative's Envision base score. More information about this ranking can be found in the *Evaluation Criteria Technical Memorandum*.

Net Environmental Benefit Rating	Envision Checklist Score	ST002-A	ST002-B	ST003/4-A	ST003/4-B
Very High	Base score + >35				
High	Base score 26-35				
Medium	Base score 16-25	X	X	X	X
Low	Base score 6-15				
Minimal	Base score 0-5				

2.8 Nutrient Credits for the Chesapeake Bay TMDL

The table below summarizes the annual load associated the storage and treatment of the combined sewer overflow based on the information provided in Table 4.2.7: Combined Sewer System Discharged and Delivered WLAs of the Phase 1 Watershed Implementation Plan (WIP) and the discharge permit requirements at AlexRenew.

Alternative	Scenario	Nitrogen (lbs/yr)	Phosphorous (lbs/yr)	TSS (lbs/yr)	N/P/TSS NPW ($ in millions)	Rating
ST002-A	A	889	185	19,903	($5.33)	Low
ST002-B	B	1,898	395	42,496	($11.39)	Very High
ST003/4-A	A	367	77	8,225	($2.20)	Minimal
ST003/4-B	B	1,129	235	25,283	($6.77)	Medium

A 20-year net present worth (NPW) cost avoidance is estimated for each parameter (N/P/TSS) based on planning level unit costs for removing the parameter through a new stormwater BMP. Planning level unit cost vary widely and are highly site specific; however, for the purposes of this evaluation unit costs of $6,000/lb for nitrogen, $25,000/lb for phosphorous, and $80/lb for TSS are assumed based on the range of costs provided in the *Cost-Effectiveness Study of Urban Stormwater BMPs in the James River Basin* (2013) completed by the Center for Watershed Protection. The parameter with the highest NPW cost is assumed to be the controlling parameter.

2.9 Permitting Issues

The storage alterative is given a high risk for permitting issues. The construction of the facilities is likely to be adjacent to the Hunting Creek embayment near CSO 002. One site, south of the Woodrow Wilson Bridge is considered herein; however, additional potential sites could include the Royal Street cul-de-sac north of the bridge, in the parking lot under the bridge, or in the Jones Point Park (National Park Service). There is also a cemetery in the area. As such permits could be required from the Virginia Department of Transportation and the National Park Service, as well as general coordination. Property acquisition may also be required.

Permitting Issues Rating	Description	ST002-A	ST002-B	ST003/4-A	ST003/4-B
High	Minimal risk of permit issues	X		X	
Medium	Moderate risk of permit issues				
Low	Significant risk of permit issues		X		X

2.10 Required Maintenance

Maintenance requirements are expected to be moderate. Preventive and corrective maintenance is required for the mechanical equipment, including the tank dewatering pumps, screening equipment, and odor control equipment. The storage tanks will need to be cleaned (e.g. hosed down) regularly.

Requirement Maintenance Rating	Description	ST002-A	ST002-B	ST003/4-A	ST003/4-B
High	Few and infrequent maintenance				
Medium	Frequent maintenance	X		X	
Low	Frequent and expensive		X		X

2.10.1 O&M Costs

Annual operation and maintenance (O&M) costs are estimated for the storage tank alternatives and scenarios.

Alternative	Scenario	Annual O&M
ST002-A	A	$0.6
ST002-B	B	$2.4
ST003/4-A	A	$0.3
ST003/4-B	B	$2.0

2.11 Net Present Worth

The NPW is estimated based on a twenty (20) year period and a 3.0% discount rate. The NPW includes the capital costs, annual O&M, and cost avoidance for constructing new stormwater BMPs.

Alternative	Scenario	Total Capital Cost	O&M NPW	N/P/TSS NPW	NPW
ST002-A	A	$29.8	$8.4	($5.3)	$32.8
ST002-B	B	$208.4	$35.8	($11.4)	$232.9
ST003/4-A	A	$54.5	$4.2	($2.2)	$56.6
ST003/4-B	B	$205.0	$29.2	($6.8)	$227.3

2.12 Recommendation for Alternative Scoring

It is recommended Alternative ST002-A and ST003/4-A be moved forward for scoring and ranking relative to the other alternatives.

Alternatives ST002-B and ST003/4-B are unfavorable and impractical due to the very large volume requirements, insufficient land availability, and extraordinarily high capital costs. It is recommended ST002-B and ST003/4-B be eliminated from further consideration.

Section 3 Opportunities for Synergy with Other Technologies

The storage tank alternatives are considered primary control strategies. Within individual basins, there are limited opportunities for synergy with other primary technologies (i.e. tunnels, disinfection, etc.). Once constructed the storage tank alternatives lend themselves well to complementary technologies including progressive separation and green infrastructure.

On an inter-basin level, the use of storage tanks does not preclude the use of other primary control strategies in other basins. For example, a storage tank could be installed for CSO-002, while a storage tunnel could be used for CSO-003/004.

Section 4 Additional Investigation Needs

If the storage alternatives are retained the following additional investigations should be considered:

- Detailed site selection study;
- Evaluation of above ground vs. below ground tanks; and
- Geotechnical borings and study.

Attachment A

Storage Tank Alternative Cost Estimates

COA LTCPU
Tank Summary

Date: 10-Apr-15
Prepared By: J. McGettigan
Checked By: C. Wilber

Rounding Digits	4
Period (years)	20
Present Worth Interes	3.0
Present Worth Factor	14.88

Capital Costs

Alternative	Storage Volume (MG)	Construction Cost	Project Costs	Land Costs	Wet Weather Improvements	Total Capital Cost
ST002-A	2.0	$19.5	$6.8	$3.5	$0.0	$29.8
ST002-B	25.9	$138.4	$48.4	$21.6	$0.0	$208.4
ST003/4-A	0.8	$10.3	$3.6	$2.9	$37.7	$54.5
ST003/4-B	18.0	$105.0	$36.8	$25.5	$37.7	$205.0

Operation and Maintenance Costs

Alternative	Scenario	Annual O&M
ST002-A	A	$0.6
ST002-B	B	$2.4
ST003/4-A	A	$0.3
ST003/4-B	B	$2.0

Nutrient and Sediment Avoidance Costs

Alternative	Scenario	Nitrogen (lbs/yr)	Phosphorous (lbs/yr)	TSS (lbs/yr)	N/P/TSS NPW
ST002-A	A	889	185	19,903	($5.3)
ST002-B	B	1,898	395	42,496	($11.4)
ST003/4-A	A	367	77	8,225	($2.2)
ST003/4-B	B	1,129	235	25,283	($6.8)

Net Present Worth

Alternative	Scenario	Total Capital Cost	O&M NPW	N/P/TSS NPW	NPW
ST002-A	A	$29.8	$8.4	($5.3)	$32.8
ST002-B	B	$208.4	$35.8	($11.4)	$232.9
ST003/4-A	A	$54.5	$4.2	($2.2)	$56.6
ST003/4-B	B	$205.0	$29.2	($6.8)	$227.3

Date: 10-Apr-15
P C. Wilber J. McGettigan
Checked By: C. Wilber

Table 1: Project Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
002 Storage Tank					
Below Grade Storage Tank	2.0	MG	Equation	$11,970,000	Cost Curve
Pump Station	2.0	MGD	Equation	$800,000	Cost Curve
				$0	
				$0	
				$0	
				$0	
				$0	
				$12,770,000	
Facilities					
Odor Control	1	EA	$300,000	$300,000	Allowance
Diversion Structure	1	EA	$600,000	$600,000	
Screening Facilities	1	LS	$750,000	$750,000	Allowance
				$1,650,000	
Subtotal				*$14,420,000*	
Construction Contingency	35%			$5,050,000	
Construction Subtotal				*$19,470,000*	
Planning, Design, CM, Administration, Permitting and Easements	35%			$6,810,000	
Land Acquisition	46,400	SF	$75	$3,480,000	
Total Project				**$29,760,000**	

Table 2: Operational and Maintenance Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
Operational Cost					
Treatment Cost at AlexRenew	37.0	MGY	$ 6.44	$ 238,280	$6.44/1,000 Gallons
Pumping Costs	6,535	kw-hrs	$ 0.08	$ 522.8	
Annual Volume	37.0	MGY			
Total Dynamic Head	30	ft			
Pump Efficiency	0.6				
Motor Efficiency	0.9				
Washdown Water (10% Tank Volume x 4)	800	TG	$ 4.00	$ 3,200	
Labor Costs	574.5	Hrs	$ 50.00	$ 28,725	
Daily Check (365@0.5hrs/each)	182.5	Hrs			
Weekly Inspections (52@2hrs/each)	104	Hrs			
Monthly Inspections (12@8hrs/each)	96				
Quarterly Cleaning (4@48hrs/each)	192	Hrs			
Maintenance Costs					
Percentage of Construction	1.50%			$ 292,050	DC LTCP Assumption
Annual O&M				$ 562,778	
Net Present Worth				$ 8,370,000	

Table 3: Stormwater Nutrient and Sediment Costs

Item	QTY	Units	Unit Cost		Total	Comments
Annual Volume	37.0	MGY				
Total Suspended Solids						
TMDL Concentration	70.50	mg/L				
Dischage Concentration	6.0	mg/L				
Removed	64.50	mg/L				
Load	19903	lbs/yr	$80	$	1,592,273	
Nitrogen						
TMDL Concentration	5.88	mg/L				
Dischage Concentration	3.0	mg/L				
Removed	2.88	mg/L				
Load	889	lbs/yr	$6,000	$	5,332,262	
Phosphorous						
TMDL Concentration	0.78	mg/L				
Dischage Concentration	0.18	mg/L				
Removed	0.60	mg/L				
Load	185	lbs/yr	$25,000	$	4,628,700	
Net Present Worth (Maximum Value)				$	5,332,262	

Date:	10-Apr-15
P C. Wilber	J. McGettigan
Checked By:	C. Wilber

Table 1: Project Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
002 Storage Tank					
Below Grade Storage Tank	25.9	MG	Equation	$88,510,000	Cost Curve
Pump Station	25.9	MGD	Equation	$6,400,000	Cost Curve
				$0	
				$0	
				$0	
				$0	
				$0	
				$94,910,000	
Facilities					
Odor Control	1	EA	$1,000,000	$1,000,000	Allowance
Diversion Structure	1	EA	$600,000	$600,000	
Screening Facilities	1	LS	$6,000,000	$6,000,000	Allowance
				$7,600,000	
Subtotal				*$102,510,000*	
Construction Contingency	35%			$35,880,000	
Construction Subtotal				*$138,390,000*	
Planning, Design, CM, Administration, Permitting and Easements	35%			$48,440,000	
Land Acquisition	288,000	SF	$75	$21,600,000	
Total Project				**$208,430,000**	

Table 2: Operational and Maintenance Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
Operational Cost					
Treatment Cost at AlexRenew	37.0	MGY	$ 6.44	$ 238,280	$6.44/1,000 Gallons
Pumping Costs	13,954	kw-hrs	$ 0.08	$ 1,116	
Annual Volume	79.0	MGY			
Total Dynamic Head	30	ft			
Pump Efficiency	0.6				
Motor Efficiency	0.9				
Washdown Water (10% Tank Volume x 4)	10360	TG	$ 4.00	$ 41,440	
Labor Costs	1053	Hrs	$ 50.00	$ 52,650	
Daily Check (365@1.0hrs/each)	365	Hrs			
Weekly Inspections (52@4hrs/each)	208	Hrs			
Monthly Inspections (12@8hrs/each)	96				
Quarterly Cleaning (4@96hrs/each)	384	Hrs			
Maintenance Costs					
Percentage of Construction	1.50%			$ 2,075,850	DC LTCP Assumption
Annual O&M				$ 2,409,336	
Net Present Worth				$ 35,840,000	

Table 3: Stormwater Nutrient and Sediment Costs

Item	QTY	Units	Unit Cost		Total	Comments
Annual Volume	79.0	MGY				
Total Suspended Solids						
TMDL Concentration	70.50	mg/L				
Dischage Concentration	6.0	mg/L				
Removed	64.50	mg/L				
Load	42496	lbs/yr	$80	$	3,399,718	
Nitrogen						
TMDL Concentration	5.88	mg/L				
Dischage Concentration	3.0	mg/L				
Removed	2.88	mg/L				
Load	1898	lbs/yr	$6,000	$	11,385,101	
Phosphorous						
TMDL Concentration	0.78	mg/L				
Dischage Concentration	0.18	mg/L				
Removed	0.60	mg/L				
Load	395	lbs/yr	$25,000	$	9,882,900	
Net Present Worth				$	11,385,101	

Date: 10-Apr-15
P C. Wilber J. McGettigan
Checked By: C. Wilber

Table 1: Project Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
003/004 Storage Tank					
Below Grade Storage Tank	0.8	MG	Equation	$5,850,000	Cost Curve
Pump Station	0.8	MGD	Equation	$510,000	Cost Curve
				$0	
				$0	
				$0	
				$0	
				$0	
				$6,360,000	
Facilities					
Odor Control	1	EA	$200,000	$200,000	Allowance
Diversion Structure	1	EA	$600,000	$600,000	
Screening Facilities	1	LS	$500,000	$500,000	Allowance
				$1,300,000	
Subtotal				*$7,660,000*	
Construction Contingency	35%			$2,680,000	
Construction Subtotal				*$10,340,000*	
Planning, Design, CM, Administration, Permitting and Easements	35%			$3,620,000	
Land Acquisition	23,100	SF	$125	$2,887,500	
Total Project				**$16,850,000**	

Table 2: Operational and Maintenance Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
Operational Cost					
Treatment Cost at AlexRenew	15.3	MGY	$ 6.44	$ 98,468	$6.44/1,000 Gallons
Pumping Costs	2,701	kw-hrs	$ 0.08	$ 216.1	
Annual Volume	15.3	MGY			
Total Dynamic Head	30	ft			
Pump Efficiency	0.6				
Motor Efficiency	0.9				
Washdown Water (10% Tank Volume x 4)	320	TG	$ 4.00	$ 1,280	
Labor Costs	574.5	Hrs	$ 50.00	$ 28,725	
Daily Check (365@0.5hrs/each)	182.5	Hrs			
Weekly Inspections (52@2hrs/each)	104	Hrs			
Monthly Inspections (12@8hrs/each)	96				
Quarterly Cleaning (4@48hrs/each)	192	Hrs			
Maintenance Costs					
Percentage of Construction	1.50%			$ 155,100	DC LTCP Assumption
Annual O&M				$ 283,789	
Net Present Worth				$ 4,220,000	

Table 3: Stormwater Nutrient and Sediment Costs

Item	QTY	Units	Unit Cost		Total	Comments
Annual Volume	15.3	MGY				
Total Suspended Solids						
TMDL Concentration	70.50	mg/L				
Dischage Concentration	6.0	mg/L				
Removed	64.50	mg/L				
Load	8225	lbs/yr	$80	$	657,996	
Nitrogen						
TMDL Concentration	5.88	mg/L				
Dischage Concentration	3.0	mg/L				
Removed	2.88	mg/L				
Load	367	lbs/yr	$6,000	$	2,203,521	
Phosphorous						
TMDL Concentration	0.78	mg/L				
Dischage Concentration	0.18	mg/L				
Removed	0.60	mg/L				
Load	77	lbs/yr	$25,000	$	1,912,779	
Net Present Worth				$	2,203,521	

Date: 10-Apr-15
P C. Wilber J. McGettigan
Checked By: C. Wilber

Table 1: Project Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
003/004 Storage Tank					
Below Grade Storage Tank	18.0	MG	Equation	$66,610,000	Cost Curve
Pump Station	18.0	MGD	Equation	$4,570,000	Cost Curve
				$0	
				$0	
				$0	
				$0	
				$0	
				$71,180,000	
Facilities					
Odor Control	1	EA	$1,000,000	$1,000,000	Allowance
Diversion Structure	1	EA	$600,000	$600,000	
Screening Facilities	1	LS	$5,000,000	$5,000,000	Allowance
				$6,600,000	
Subtotal				*$77,780,000*	
Construction Contingency	35%			$27,220,000	
Construction Subtotal				*$105,000,000*	
Planning, Design, CM, Administration, Permitting and Easements	35%			$36,750,000	
Land Acquisition	204,000	SF	$125	$25,500,000	
Total Project				**$167,250,000**	

Table 2: Operational and Maintenance Cost Estimate

Item	QTY	Units	Unit Cost	Total	Comments
Operational Cost					
Treatment Cost at AlexRenew	47.0	MGY	$ 6.44	$ 302,680	$6.44/1,000 Gallons
Pumping Costs	8,302	kw-hrs	$ 0.08	$ 664.1	
Annual Volume	47.0	MGY			
Total Dynamic Head	30	ft			
Pump Efficiency	0.6				
Motor Efficiency	0.9				
Washdown Water (10% Tank Volume x 4)	7200	TG	$ 4.00	$ 28,800	
Labor Costs	1053	Hrs	$ 50.00	$ 52,650	
Daily Check (365@1.0hrs/each)	365	Hrs			
Weekly Inspections (52@4hrs/each)	208	Hrs			
Monthly Inspections (12@8hrs/each)	96				
Quarterly Cleaning (4@96hrs/each)	384	Hrs			
Maintenance Costs					
Percentage of Construction	1.50%			$ 1,575,000	DC LTCP Assumption
Annual O&M				$ 1,959,794	
Net Present Worth				$ 29,160,000	

Table 3: Stormwater Nutrient and Sediment Costs

Item	QTY	Units	Unit Cost	Total	Comments
Annual Volume	47.0	MGY			
Total Suspended Solids					
TMDL Concentration	70.50	mg/L			
Dischage Concentration	6.0	mg/L			
Removed	64.50	mg/L			
Load	25283	lbs/yr	$80	$ 2,022,617	
Nitrogen					
TMDL Concentration	5.88	mg/L			
Dischage Concentration	3.0	mg/L			
Removed	2.88	mg/L			
Load	1129	lbs/yr	$6,000	$ 6,773,414	
Phosphorous					
TMDL Concentration	0.78	mg/L			
Dischage Concentration	0.18	mg/L			
Removed	0.60	mg/L			
Load	235	lbs/yr	$25,000	$ 5,879,700	
Net Present Worth				$ 6,773,414	

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